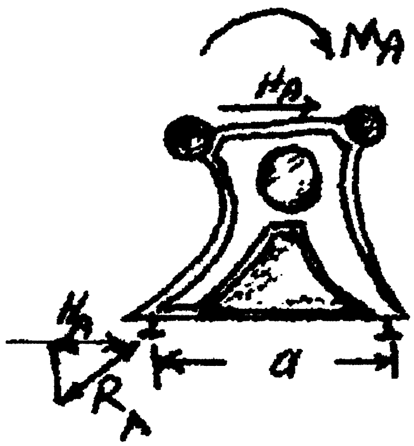
Appendix A - Sample Analysis

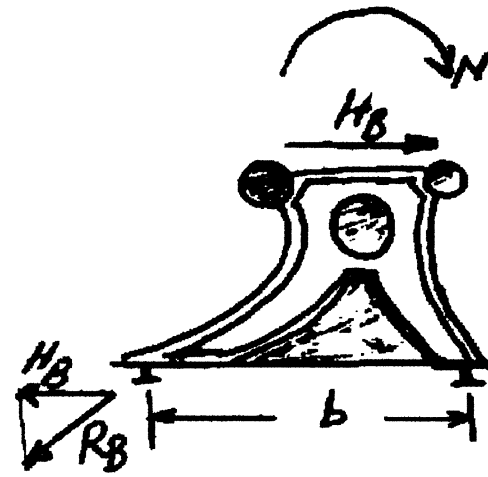
Example:

An example and a thought process of analytically justifying the suitability of a variant of a seat component for inclusion in a family of seats without a full scale test will be presented. The demonstration of the process will relate to a seat with a variation in the seat leg consisting of increasing the fore-aft distance between the front and rear attachment of the leg to the aircraft floor.

Problem Statement:

1. Assume that a family of seats utilizing a leg (Leg A) with a certain leg pitch has been defined and certified.
2. The critical seat based on maximum reaction load has been established using the calculated interface loads derived in an acceptable manner. This seat, where leg A is the critical seat of the family based on reaction loads, has been tested.
3. A new configuration presents itself wherein all primary structural components except the leg, Leg B, of the seat belong in the family established by test. Leg B which has not been tested possesses sufficient commonality with Leg A, based on the criteria and methodology presented in Section 3.0 that an analytical evaluation is justifiable using the methodology below:
4. A schematic representation of Legs A and B are shown below. Shear load H and moment M schematically represent applied loads to the legs. For clarity only the resultant reaction at the rear attachment to the aircraft track is shown, represented by R whose horizontal component reacts load H :





a ≤ b

LEG A
Longitudinal Loading

LEG B
Longitudinal Loading

Solution Part I, Longitudinal performance:

1. $R_A > R_B$ has been determined from an interface loads analysis for the forward longitudinal loading condition (otherwise a test would be required). The values for applied loads H, M or equivalent load input information would be based on the interface loads analyses that yield R_A and R_B.

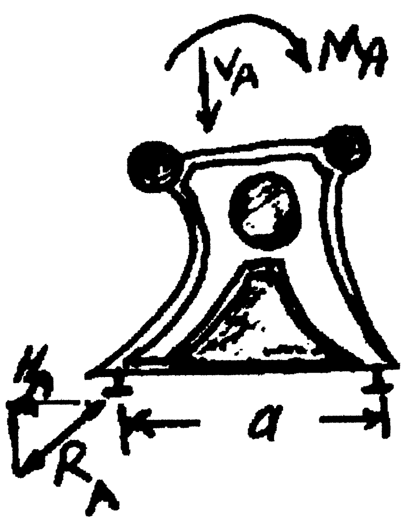
2. Perform a stress analysis of Leg A to determine internal stresses/strains under loads H_A and M_A. Similarly, perform a stress analysis of Leg B to determine internal stresses/strains under loads H_B and M_B.

3. Verify, or adjust the design of Leg B as required, so that no stress/strain in Leg B is greater than in Leg A location for location within the seat leg. Attachment hardware should be included in this verification.

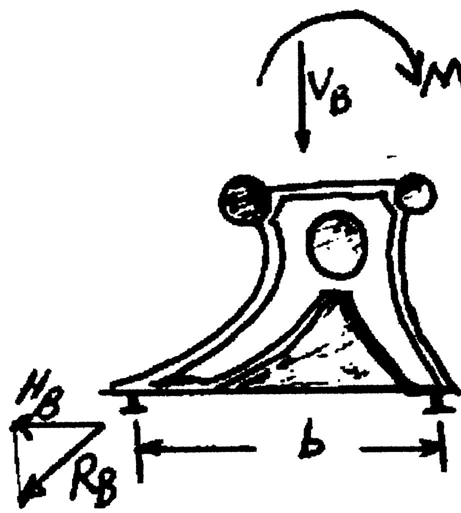
   If hand calculations are used, this requirement can involve substantial effort to demonstrate that the critical stress/strain location(s) are known and that as a result of the design change the stress/strain distribution of the new design has not changed. A global evaluation method (e.g. finite element) will determine the total stress state of the part overcoming that difficulty.

4. Calculate the forward deflection of the structure at the waterline at which H_A and H_B are applied. The deflections d_A and d_B are calculated for Leg A under H_A and M_A loading and for Leg B under H_B and M_B loading respectively. Calculate the longitudinal stiffness K_A of Leg A, and K_B, the longitudinal stiffness of Leg B wherein $K_A = H_A/d_A$ and $K_B = H_B/d_B$. Verify, or adjust the design of Leg B as required, that $K_B \leq K_A$.

Solution Part II, Vertical performance:



LEG A
Vertical Loading



LEG B
Vertical Loading

1. Perform an interface load analysis of the two seats in question to establish R_A and R_B under a vertical load condition.

2. If not obvious by comparison or from the results of solution Part I step 2; perform a stress analysis of Leg A to determine internal stresses/strains under V_A and M_A. Similarly, perform a stress analysis of Leg B to determine internal stresses/strains under V_B and M_B loading. V_A and M_A are the input loads resulting from the interface loads analysis of the seat with leg A. V_B and M_B are the input loads resulting from the interface loads analysis of the seat with Leg B.

3. Verify, or adjust, the design of Leg B as required, so that no stress/strain in Leg B is greater than in Leg A location for location within the seat leg. Attachment hardware should be included in this verification.

   If hand calculations are used, this requirement can involve substantial effort to demonstrate that the critical stress/strain location(s) are known and that as a result of the design change the stress/strain distribution of the new design has not changed. A global evaluation method (e.g. finite element) will determine the total stress state of the part overcoming that difficulty.

4. Calculate vertical deflection d_A for Leg A and vertical deflection d_B for Leg B at a fore-aft station aligned with the CG of the occupant used in the interface load analysis for vertical loading. The deflections d_A and d_B are calculated for Leg A under V_A and M_A loading and for Leg B under VB and M_B loading respectively. Calculate K_A, the vertical stiffness of Leg A, and K_B, the vertical stiffness of Leg B wherein $K_A = V_A/d_A$ and $K_B = V_B/d_B$. Verify, or adjust the design of Leg B as required, that $K_B \leq K_A$.